

## REMARKS

Favorable reconsideration is respectfully requested.

Upon entry of the above amendment, the claims will be 1 to 3, 5, 7 to 17, 19, 20 and 28 to 40.

With regard to the above amendments, support is as follows:

- 1) The amendment of "contaminated matter", e.g. in claim 1, to --contaminated soil, sediment or sludge-- is supported, for example, page 1, lines 6-7 of the specification.
- 2) The amendment concerning "the oxidation reduction potential of the contaminated matter" in Claims 1, 13, 28, 36 and 38 is based on Examples 5-8 of the specification.
- 3) Newly added claims 37, 39 and 40 are based on Examples of the specification.

The above amendment is responsive to points set forth in the Official Action.

Turning to the rejections under 35 USC 112, the Official Action questions whether there is any difference between a "manganese magnesium" alloy and a "magnesium manganese" alloy. In reply, the term "magnesium manganese" has been deleted from claims 5 and 17.

The Official Action questions whether, in claims 15-17, if the recited limitation is in terms of the contaminated matter prior to the addition of the reducing agent or after addition of the reducing agent.

In reply, the phrase "prior" has been inserted "to the addition of the reducing agent" in claims 15 and 16.

Claims 1, 2, 8, 12, 13, 28, 30 and 31 are rejected under 35 USC 102(b) as being anticipated by Seech et al (U.S. 5,480,579).

This rejection is respectfully traversed.

Seech et al disclose a method of purifying contaminated matter by using a composition comprising a mixture of fibrous organic matter which is capable of supporting bacteria or fungal growth and multi-valent metal particles wherein the weight ratio of metal particles : organic matter ranges from 1:1 to 1:500,000 respectively. According to Seech et al, a combination of fibrous organic material with multi-valent metal particles is essential. However, according to the present invention, a reducing agent is added alone or with a water-soluble nutritional organic

compound to the contaminant matter. Thus, the use of fibrous organic matter is not essential in the present invention.

In addition, one of the remarkable features of the present invention is to use a reducing agent having a standard electrode potential ranging from 130 mV to -2400 mV and a water-soluble organic matter, whereby an oxidation reduction potential of the contaminated matter reduced and maintained not more than -350 mV at least 5 days by adding the reducing agent. Please refer to above-amended claim 1. By creating such conditions, chlorinated organic compounds such as polychloroethanes can be completely converted to ethylene or ethane by dechlorination in a short time such as 40 days. Please refer to Examples 4-9 and 11 of the present application.

In contrast, Seech et al discloses in Examples 1 and 2 that Dieldrin and Endrin remained, after one month of the treatment, 34-33% and 51-28%, respectively. Furthermore, Example 3 of Seech et al discloses that when a soil sample containing DDT was tested, 14% of DDT remained after the treatment.

Thus, the advantages of the present invention over Seech et al are remarkable.

In addition, the amended claims of the present invention deleted "cast iron" to limit "reduced iron" thereby clarifying the use of reduced iron if iron is used as the reducing agent. However, Seech et al does not teach or suggest such a particular form of iron, i.e. reduced iron.

For the reasons stated above, the present claims are both novel and unobvious from Seech et al.

The above comments are also applicable with regard to the rejections of claims 29 and 32 to 35 under 35 USC 103(a) as unpatentable over Seech et al.

Claims 1-4, 6, 7, 10, 11, 13, 18, 19, 28, 29, 31 and 34 are rejected under 35 USC 102(b) as being anticipated by Haitko et al (U.S. 5,362,402).

This rejection is also respectfully traversed.

Haitko et al discloses a method for dehalogenation of aqueous composition contaminated with halogenated hydrocarbon compounds with an amount of metallic iron effective to dehalogenate the halogenated hydrocarbons in the presence of citric acid.

The contaminated matter to be treated by the method of Haitko et al is aqueous compositions which include contaminated water and aqueous solutions contaminated with halogenated hydrocarbon compounds. Please refer to column 2, lines 53-66.

The contaminated matter of Haitko et al includes only water. While the amended claims of the present application are directed to treatment of contaminated soil, sediment or sludge.

In addition, Haitko et al does not disclose or suggest that citric acid acted as a nutrient for microorganism present in water. Haitko et al succeeded with use of acid to increase the reaction speed between iron metal with halogenated organic compounds and to decrease the amount of iron metal used. As shown in Tables 1-4, the dechlorination of trichloroethylene occurred for a relatively short time, such as about a one hour half-life of the reaction. Citric acid will not be utilized as a nutrient for microorganisms if they are present. Thus, it is considered that Haitko et al did not intend or recognize any synergistic effect of a chemical reaction and biological reaction as realized in the present invention.

Claims 1, 2, 6, 7, 9-11, 13, 18, 19, 28 and 34 are rejected under 35 USC 102(b) as being anticipated by DeWeerd et al (U.S. 5,484,729).

This rejection is also respectfully traversed.

DeWeerd et al disclose a method for accelerating anaerobic microbial dechlorination of more highly chlorinated PCBs in aqueous sediment which contains anaerobic microorganisms capable of dechlorinating PCBs, which comprises the steps of:

1) proscreening for the presence of anaerobic microorganisms capable of dechlorinating PCBs by

(a) adding an halogen-substituted acid or acid derivative to a portion of the sediment containing PCBs;

(b) allowing the resulting mixture to incubate under anaerobic conditions at a temperature between about 5°C and about 55°C for a period of about 20 days; and

(c) measuring the remaining amount of highly chlorinated PCBs; and substantial decrease in the concentration of more highly chlorinated PCBs; and

2) adding to and admixing with the balance of the sediment a halogen-substituted compound, and incubating the sediment under conditions sufficient to effect dechlorination of said more highly chlorinated PCBs.

According to the method of DeWeerd, highly chlorinated PCBs, for example some of PCBs shown in the Table in column 4 of DeWeerd, in sediment, are dechlorinated and converted to PCBs having less chlorination by the action of anaerobic microorganisms in the presence of a halogen-substituted acid or acid derivative. Thus, the addition of a halogen-substituted acid or acid derivative to sediment is essential. In contrast, according to the present invention, no halogenated organic compound is used as a reducing agent.

Furthermore, DeWeerd does not teach or suggest the use of reducing agents having a specific range of oxidation reduction potential, which is an essential component of the present invention. Therefore, DeWeerd does not disclose or suggest that an oxidation reduction potential after mixing the contaminated matter with a reducing agent should be maintained at a low level such as not more than -350 mV for at least 5 days. This feature is essential in the present invention. Please refer to the above amended claims.

In addition, the object of DeWeerd is to decrease the toxicity, carcinogenecity and bioaccumulation of the PCBs and to increase their susceptibility to further biodegradation by aerobic bacteria and metabolism by higher organisms. The object of DeWeerd resides in dechlorination of highly chlorinated PCB compounds to convert them into less chlorinated PCBs. Please refer to column 3, lines 13-25 of DeWeerd.

On the other hand, the object of the invention of this application is to completely convert halogenated organic compounds in a contaminated matter into non-halogenated organic compounds.

For the reasons stated above, the present invention is both novel and unobvious from DeWeerd.

The above comments are also applicable with respect to the rejection of claims 32, 33 and 35 under 35 USC 103(a) as being unpatentable over DeWeerd et al. (U.S. 5,484,729).

Claims 1-20 and 28-35 are rejected under 35 USC 103(a) as being unpatentable over Schuring et al (U.S. 5,908,267).

This rejection is also respectfully traversed.

Schuring et al discloses a method for pneumatically injecting dry media into a soil formation comprising:

- (a) pneumatically fracturing said soil formation by inserting a tubular probe into the soil formation and supplying a pressurized gas into said tubular probe to produce a fracture network in the soil formation,
- (b) preserving said fracture network in a dilated state or by maintaining continuous injection of said gas,
- (c) introducing dry media into said gas in order to assure adequate dispersion and distribution of the dry media through the soil formation, and
- (d) continuing injection of said dry media into said fracture network.

The dry media comprises one or more components such as silica, carbon, powdered metal, particles and beads of synthetic resin, organic compounds, and compositions which promote the growth and activity of microorganisms in said soil formation. The dry media is capable of reducing or eliminating non-naturally occurring compositions (or contaminants).

The present inventors knew prior to filing of the present application that metallic iron and high-pressure air can be injected into soil for reacting iron powder with halogenated organic compounds (contaminants) in the soil to convert them into inorganic compounds. Please refer to page 3, lines 20-28 of the present specification. However, the method has a disadvantage as described in the specification, in that halogenated organic compounds (contaminants) may diffuse and the high-pressure air increases costs. In addition, if Schuring et al intended to use a reducing agent such as reduced iron, the reducing agent should not contact oxygen before reacting with contaminants such as halogenated organic compounds. The reducing agent reacts with the contaminant to reduce halogenated compounds into dehalogenated compounds. If the reducing agent contacts oxygen and is oxidized at least partially, its activity will be reduced. In order to prevent the reducing agent from undergoing partial oxidation before reaction with the

contaminant, the carrier gas should not contain oxygen. Thus, a nitrogen gas can be used but it is expensive. In fact, Schuring et al used a nitrogen gas as pressurizing carrier gas. (See column 8, lines 35-53 of Schuring et al.)

According to Schuring et al., dry media which is carried on a carrier gas is delivered to an area contaminated with non-naturally occurring compositions through a fracture network. Thus, the dry media does not reach the area of soil formation where fracturing is not produced. In order to be decomposed or dehalogenated, the halogenated compound should contact a reducing agent. It is possible to produce a media layer in or along a groundwater stream thereby contacting contaminant in the groundwater to dehalogenize or decompose the contaminant. However, an area where the media is not delivered is not purified because the media is in a dry state.

If there is a groundwater stream in such area, the contaminant is diffused or effused from the area to a place where media is delivered and retained and contact with the media. However, this effects are hardly expected if the Schuring et al method is applied to the ground where water permeability is low.

Furthermore, Schuring et al. does not teach or suggest that a reducing agent having a specific range of oxidation reduction potential should be used; that iron should be used in the reduced form; that a reducing agent should fully contact the halogenated organic compound (contaminant); and that an oxidation reduction potential after mixing the contaminated matter with a reducing agent should be maintained at a low level. It is important to achieve these features so that a reducing agent which is in a slurry form is mixed with contaminated matter, or that a reducing agent is mixed with a slurry form of contaminated matter. Please refer to claims 37 and 39.

For the reasons stated above, the present claims are both novel and unobvious from Schuring et al.

No further issues remaining, allowance of this application is respectfully requested.

If the Examiner has any comments or proposals for expediting prosecution, please contact undersigned at the telephone number below.

Respectfully submitted,

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**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

**IN THE CLAIMS:**

*Claims 1 to 3, 5, 7 to 17, 19, 20 and 28 to 35 have been amended as follows:*

1. (Amended) A method for purifying matter-soil, sediment or sludge contaminated with a halogenated organic compound, which method comprises the step of: adding a reducing agent and a water-soluble organic nutritional source for a heterotrophic anaerobic microorganism to the contaminated matter, the reducing agent having a standard electrode potential ranging from 130 mV to -2400 mV at 25°C with respect to the standard hydrogen electrode, the reducing agent being at least one species selected from the group consisting of reduced iron, ~~cast iron~~, an iron-silicon alloy, a titanium alloy, a zinc alloy, a manganese alloy, an aluminum alloy, a magnesium alloy [,] and a calcium alloy and a water-soluble compound, whereby an oxidation reduction potential of the contaminated matter reduced is maintained at not more than -350 mV for at least 5 days by adding the reducing agent.
2. (Amended) The A method of claim 1 wherein the reducing agent has a standard electrode potential ranging from -400 mV to -2400 mV at 25°C with respect to the standard hydrogen electrode, and the reducing agent is being at least one species selected from the group consisting of the reduced iron, ~~the cast iron~~, the iron-silicon alloy, the titanium alloy, the zinc alloy, the manganese alloy, the aluminum alloy, the magnesium alloy, and the calcium alloy.
3. (Amended) The A method of claim 1 wherein the reducing agent comprises the reduced iron.
5. (Amended) The A method of claim 1 wherein the reducing agent is being at

least one species selected from the group consisting of the iron-silicon alloy, a titanium-silicon alloy, a titanium-aluminum alloy, a zinc-aluminum alloy, a manganese-magnesium alloy, an aluminum-zinc-calcium alloy, an aluminum-tin alloy, an aluminum-silicon alloy, a magnesium-manganese alloy and a calcium-silicon alloy.

7. (Amended) The A method of claim 636 wherein the reducing agent is an organic acid or derivative thereof, hypophosphorous acid or derivative thereof, or a sulfide salt.

8. (Amended) The A method of claim 1 wherein the reducing agent is a powder having a diameter up to 500  $\mu$ m.

9. (Amended) The A method of claim 1 wherein the contaminated matter has a water content of at least 25 percent by weight.

10. (Amended) The A method of claim 1, further comprising the step of maintaining the contaminated matter in a pH ranging from 4.5 to 9.0 subsequent to the adding step.

11. (Amended) The A method of claim 1, further comprising the step of maintaining the contaminated matter in a pH ranging from 4.5 to 9.0 under a reducing atmosphere subsequent to the adding step.

12. (Amended) The A method of claim 1, further comprising the steps of adding an organic compost, a compostable organic material, a waste water containing organic matter or a waste containing organic matter to the contaminated matter and mixing thereof.

13. (Amended) A method for purifying ~~matter~~ soil, sediment or sludge contaminated with a halogenated organic compound, which method comprises the step of adding a reducing agent to the contaminated matter, the reducing agent having a

standard electrode potential ranging from 130 mV to -2400 mV at 25°C with respect to the standard hydrogen electrode, the reducing agent is being at least one species selected from the group consisting of reduced iron, ~~east-iron~~, an iron-silicon alloy, a titanium alloy, a zinc alloy, a manganese alloy, an aluminum alloy, a magnesium alloy and a calcium alloy, whereby an oxidation reduction potential of the contaminated matter reduced is maintained at not more than -350 mV for at least 5 days by adding the reducing agent.  
; and a water-soluble compound:

14. (Amended) The A method of claim 13 wherein the reducing agent has the standard electrode potential ranging from -445 mV to -2400 mV at 25°C with respect to the standard hydrogen electrode, and the reducing agent is at least one species selected from the group consisting of the iron-silicon alloy, the titanium alloy, the zinc alloy, the manganese alloy, the aluminum alloy, the magnesium alloy, and the calcium alloy.

15. (Amended) The A method of claim 14 wherein the contaminated matter prior to the addition of the reducing agent comprises 0.1 g to 100 g of an iron compound based on 1 kg of a dry weight of the contaminated matter.

16. (Amended) The A method of claim 14 wherein the contaminated matter prior to the addition of the reducing agent comprises 1 g to 100 g of an iron compound based on 1 kg of a dry weight of the contaminated matter, and the iron compound comprises iron hydroxide ( $Fe(OH)_3$ ) or triiron tetraoxide ( $Fe_3O_4$ ).

17. (Amended) The A method of claim 15 wherein the reducing agent is at least one species selected from the group consisting of the iron-silicon alloy, titanium-silicon alloy, titanium-aluminum alloy, zinc-aluminum alloy, manganese-magnesium alloy, aluminum-zinc-calcium alloy, aluminum-tin alloy, aluminum-silicon alloy, magnesium-manganese alloy and calcium-silicon alloy.

19. (Amended) The A method of claim 1838 wherein the reducing agent is an organic acid or derivative thereof, hypophosphorous acid or derivative thereof, or a sulfide salt.

20. (Amended) The A method of claim 13 wherein the reducing agent is a powder having a diameter up to 500  $\mu\text{m}$ .

28. (Amended) A method of purifying a contaminated matter soil, sediment or sludge containing a halogenated compound and a solid matter, which method comprises the step of:

mixing a reducing agent and a water-soluble organic nutritional liquid containing a nutritional source for a heterotrophic anaerobic microorganism and water with the contaminated matter, the reducing agent having a standard electrode potential ranging from 130 mV to -2400 mV at 25°C with respect to the standard hydrogen electrode, wherein the mixing step including includes a step of adjusting the contaminated matter at pH ranging from 4.5 to 9.0, whereby an oxidation reduction potential of the contaminated matter reduced is maintained at not more than -350 mV for at least 5 days by adding the reducing agent; and

keeping the mixture in a condition such that air hardly penetrates through a matrix of said mixture.

29. (Amended) The A method of claim 28 wherein the reducing agent is in a powder form and wherein the nutritional liquid is added to the contaminated matter and mixed thereof, and then the reducing agent is added to the resultant mixture and further mixed thereof therewith.

30. (Amended) The A method of claim 28 wherein the reducing agent is a powder having a diameter up to 500  $\mu\text{m}$ .

31. (Amended) The A method of claim 28 wherein the reducing agent is at least one species selected from the group consisting of reduced iron, ~~cast iron~~, iron-silicon alloy, titanium alloy, zinc alloy, manganese alloy, aluminum alloy, magnesium alloy and calcium alloy.

32. (Amended) The A method of claim 28 wherein 1 to 10 percent by volume, based on the contaminated matter, of the nutritional liquid is added to the contaminated matter and mixed thereof therewith as a first step; and then an amount larger than the amount of the first step of the nutritional liquid is added to the contaminated matter and mixed thereof therewith as a second step.

33. (Amended) The A method of claim 28 wherein:  
1 to 5 percent by volume, based on the contaminated matter, of the nutritional liquid is added to the contaminated matter and mixed thereof therewith as a first step;  
the nutritional liquid is added to the contaminated matter and mixed thereof therewith as a second step wherein a sum of the nutritional liquids added in the first step and the second step amounts 5 to 10 percent by volume, based on the contaminated matter, of the contaminated liquid; and  
the nutritional liquid is added to the contaminated matter and mixed thereof therewith as a third step wherein an amount of the nutritional liquid added in the third step is more than an amount of the nutritional liquid added in either the first step or the second step.

34. (Amended) The A method of claim 28 wherein the reducing agent is a water soluble compound, and the reducing agent is dissolved in the nutritional liquid.

35. (Amended) The A method of claim 28 wherein in the keeping step the mixture is kept at a temperature ranging from 17°C to 60°C for at least an initial three days.